

WHAT IS CLAIMED IS:

1. A sensing element for a capacitive sensor, comprising:
 - a body of dielectric material;
 - a surface plate disposed on the dielectric body, the surface plate having an upper surface defining a portion of a sensing surface of the capacitive sensor;
 - first and second plates separated from each other and from the surface plate by portions of the dielectric body;
 - a third plate separated from the surface plate, the first plate and the second plate by portions of the dielectric body; and
 - a conductor connecting the third plate to the surface plate;wherein the first plate defines a first capacitor with the third plate, and wherein the second plate defines a second capacitor with the third plate, the first and second capacitors being connected in series in a circuit within the capacitive sensor for communicating a signal therein that is a function of a variable capacitance sensed at the upper surface of the surface plate.
2. The sensing element of Claim 1 wherein the first, second and third plates are each embedded in the dielectric body a like distance beneath the surface plate, the third plate lying between and adjacent to the first and second plates, the first capacitor being defined by respective facing edges of the first and third plates, the second capacitor being defined by respective facing edges of the second and third plates.

3. The sensing element of Claim 2 wherein the first and second plates have fingers extending toward the third plate, and the third plate has fingers extending toward the first and second plates, the fingers of the first plate lying in an interdigitated relationship to adjacent fingers of the third plate and forming the facing edges that define the first capacitor, and the fingers of the second plate lying in an interdigitated relationship to adjacent fingers of the third plate and forming the facing edges that define the second capacitor.

4. The sensing element of Claim 1 wherein the first and second plates are embedded in the dielectric body beneath the surface plate and separated therefrom by a first thickness of dielectric material, and the third plate is disposed beneath the first and second plates and separated therefrom by a second thickness of dielectric material, the first thickness being greater than ten microns and the second thickness being less than one micron.

5. The sensing element of Claim 1 wherein the third plate is embedded in the dielectric body beneath the surface plate and separated therefrom by a first thickness of dielectric material, and the first and second plates are disposed beneath the third plate and separated therefrom by a second thickness of dielectric material, the first thickness being greater than ten microns and the second thickness being less than one micron.

6. The sensing element of Claim 1 wherein the first, second and third plates consist essentially of aluminum embedded in the dielectric body.

7. The sensing element of Claim 1 wherein the surface plate consists essentially of titanium oxide.

8. In a fingerprint sensor having a plurality of pixels for capacitively sensing a fingerprint of a user's finger, each pixel having a sensing element coupled to an amplifier for generating an output corresponding to a fingerprint characteristic appearing at the pixel location, the sensing element comprising:

a body of dielectric material;

a surface plate of conductive material retained by the dielectric body and having a flat upper surface defining a sensing surface for contact with the fingerprint-bearing skin of a user's finger;

first and second coplanar plates embedded in the dielectric body at a first level below the surface plate; and

a third plate embedded in the dielectric body at a second level below the surface plate and parallel to the first and second plates, the third plate being connected by a conductor to the surface plate;

wherein a first capacitor is formed by the third plate and the first plate, a second capacitor is formed by the third plate and the second plate, and a fingerprint capacitor is formed between the surface plate and the skin of the user's finger thereover during a sensing operation.

9. The sensing element of Claim 8 wherein the first level is above the second level.

10. The sensing element of Claim 9 wherein the thickness of the portion of the dielectric body separating the surface plate from the first and second coplanar plates is at least ten times greater than the thickness of the portion of the dielectric body separating the first and second coplanar plates from the third plate therebelow.

11. The sensing element of Claim 8 wherein the first level is below the second level.

12. The sensing element of Claim 11 wherein the thickness of the portion of the dielectric body separating the surface plate from the third plate is at least ten times greater than the thickness of the portion of the dielectric body separating the third plate from the first and second coplanar plates therebelow.

13. The sensing element of Claim 8 wherein the dielectric body includes a thin layer separating the third plate from the first and second plates, the thin dielectric layer having a thickness of less than one micron.

14. The sensing element of Claim 13 wherein the thickness of the thin dielectric layer is from 0.2 to 0.3 micron.

15. A fingerprint sensing device having a plurality of pixels formed within semiconductor and dielectric material, the dielectric material disposed atop the semiconductor material and having flat exposed surface portions, each pixel comprising:

5 a surface plate retained by the dielectric material at the sensing surface, the surface plate having a flat upper surface that defines a sensing surface with surrounding flat surface portions of the dielectric material;

first and second plates embedded in the dielectric material at a level beneath and lying parallel to the surface plate; and

10 an amplifier having an input connected to the second plate and an output for generating a pixel output signal in response to an input pulse applied to the first plate;

15 wherein a fingerprint capacitor having a variable capacitance is formed by the surface plate and a portion of the fingerprint-bearing skin of a user's finger applied to the sensing surface, said portion being disposed directly above the surface plate with the skin applied to the sensing surface, wherein first and second capacitors are formed between the surface plate and the respective first and second embedded plates, and wherein the pixel output signal varies with the capacitance value of the fingerprint capacitor to indicate the proximity of the skin of the user's finger to the surface plate when the input pulse is applied to the first plate.

16. The fingerprint sensing device of Claim 15 further comprising a feedback capacitor connected across the amplifier.

17. The fingerprint sensing device of Claim 16 further comprising a reset transistor connected across the amplifier in parallel with the feedback capacitor.

18. The fingerprint sensing device of Claim 15 further comprising a third embedded plate lying between and coplanar with the first and second embedded plates, wherein the third embedded plate is connected to the surface plate and has edges facing respective opposed edges of the first and second plates.

19. The fingerprint sensing device of Claim 18 wherein the thickness of the dielectric material separating the embedded plates from the surface plate is more than ten times greater than the distance separating edges of the third plate from the opposed edges of the first and second plates, wherein the first and second capacitors are defined primarily between the edges of the third plate and the respective opposed edges of the first and second plates.

20. The fingerprint sensing device of Claim 15 further comprising a third plate embedded in the dielectric material in a plane parallel to the surface plate at a level different from the level of the first and second plates, and a thin dielectric layer disposed between the third plate and the first plate to define the first capacitor and between the third plate and the second plate to define the second capacitor.